DOCUMENT RESUME

ED 117 566 CE 006 283

TITLE	Career Education Resource Guide for Physics. (Tentative.)
INSTITUTION	Louisiana State Dept. of Education, Baton Rouge.
REPORT NO	Bull-1352; VT-102-462
PUB DATE	74
NOTE	26p.; For related documents, see CE 006 282-291
EDRS PRICE	MF-$0.83 HC-$2.06 Plus Postage
DESCRIPTORS	*Career Education; *Career Opportunities; Career Planning; Curriculum; Hobbies; *Learning Activities; Occupational Information; *Physics; *Resource Guides; Science Curriculum; Secondary Education
IDENTIFIERS	Louisiana

ABSTRACT

The career education resource guide integrates learning activities in basic physics with an exploration of careers in physics or related fields. The guide is keyed to the physics textbooks and laboratory manuals adopted by the Louisiana State Department of Education in 1973. The field of physics is divided into six subject areas: (1) the description of motion, (2) mechanics, (3) thermodynamics, (4) waves, (5) electricity and magnetism, and (6) modern physics. For each subject area, a subject guide, suggested objectives, and career exploration activities are given. The subject guide attempts to keep the curriculum material in perspective. The suggested objectives are referenced, where possible, to experiments in the laboratory manuals on the State adopted list. The career exploration activities center on careers and hobbies that are related to that particular area of physics. An introductory career activity unit precedes that six subject areas and a culminating career activity unit follows. The appendixes include a classified list of physics-related hobbies and careers. (Author/NJ)

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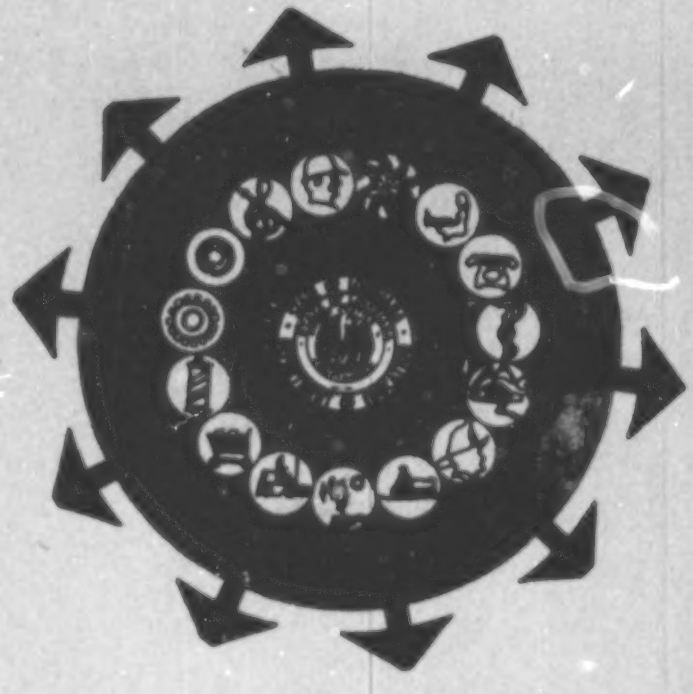

CAREER EDUCATION RESOURCE GUIDE FOR PHYSICS

1974
LOUIS J. MICHOT
STATE SUPERINTENDENT OF EDUCATION

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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RESOURCE GUIDE

FOR

HIGH SCHOOL PHYSICS

1974

VT 102462

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Physics Textbooks and Related Materials Adopted by the Louisiana State Department of Education, 1973 and Codes to references cited in Suggested Objectives

Code

The World of Physics, Hulsizer-Lazarus; Addison-Wesley Publishing Company, Inc., 1972.

G Laboratory Manual for the World of Physics Gottlieb, Herbert H., Addison Wesley, 1972.

Physics, A Basic Science, Verwiebe, etal; American Book Company, 1970.

V Laboratory Course, Verwiebe, etal, 1970.

The Project Physics Course, Rutherford, etal; Holt, Rinehart and Winston, Inc., 1970.

PPC Project Physics Handbook, 1970
Project Physics Readers
Project Physics Transparencies
Project Physics Film Loops

Physics: Principles and Problems, Murphy-Smoot; The Charles E. Merrill Publishing Division of Bell & Howell Company, 1972.

M Laboratory Physics, Murphy, 1972.

Investigations in Physics, Renner-Packard; Rand McNally and Company, 1974.

R Laboratory Manual, Renner-Packard, 1974.

Physics, Genzer-Youngner; Silver Burdett Division of General Learning Corporation, 1973.

GY Laboratory Investigations (Manual), Genzer-Youngner, 1973.

PSSC Physics, 3rd edition, Haber-Schaim; D.C. Heath and Company, 1971.

PSSC Laboratory Guide to accompany PSSC Physics, Haber-Schaim, 1971.

INTRODUCTION

The purpose of this resource guide is to aid the high school physics teacher in organizing the physics course, in using the resources available, and in relating physics to careers. The guide is keyed to the physics textbooks and laboratory manuals adopted by the State Department of Education in 1973. A list of these books and manuals is given on the previous page. It is suggested that the teacher secure at least one copy of each of the 1973 adoptions. It is a common practice for publishing companies to send free examination copies to those teachers who request them.

The resource guide should be viewed as an aid and not as a restriction: it is not intended that every concept be introduced nor that every objective be attempted. Rather, the teacher is encouraged to be flexible and creative, to try different teaching methods and styles, and to adapt the course to the particular needs of the students. At the same time, the teacher is encouraged to stress those concepts that are fundamental to physics, and, wherever possible, to relate the ideas of physics to other disciplines.

Laboratory experience is crucial to the understanding of physics. Even where space is limited and equipment is inadequate, the student should be given every possible opportunity to explore the principles of physics directly through experiment. Although direct experience by the student is preferable, demonstrations by the teacher can also be an effective teaching device. Reference to a wide variety of experiments is made along with the objectives suggested in this guide. However, this list of references is not exhaustive. Ideas for other experiments, activities, and demonstrations can be found in the laboratory manuals, in the teacher guides that accompany the texts, and in the journals listed in the appendix.

The guide is organized in the following way: The field of physics is divided into six subject matter areas: (I) The Description of Motion, (II) Mechanics, (III) Thermodynamics, (IV) Waves, (V) Electricity and Magnetism, and (VI) Modern Physics. For each subject matter area, there is given a subject guide, suggested objectives, and career exploration activities. The subject guide attempts to keep the curriculum material in perspective and to point out areas where students are likely to have difficulty. The suggested objectives are referenced, where possible, to experiments in the laboratory manuals on the state adopted list. The career exploration activities center around careers and hobbies that are related to that particular area of physics.

An introductory career activity unit precedes the six subject matter areas, and a culminating career activity unit follows. Since many of the career exploration activities are designed to require little teacher supervision, the teacher is urged to make use of the introductory career unit so that the student may then continue his career exploration activities independently. Items one and two of the introductory unit may be a part of the on-going program of the guidance department and therefore may not need to be re-emphasized at this point; this decision should be made in consultation with the guidance counsellor. Item three will need to be done. The culminating activity should be done towards the end of the year.

The appendices include a classified list of Physics-related hobbies and careers. This list can be used to substitute other careers for those chosen for exploration activities with each subject matter area.

INTRODUCTORY CAREER ACTIVITY

I. Guidance Resources

Students will be expected to work independently on many of the career activities described later in the curriculum guide.

If your guidance department does not have an on-going program that familiarizes the student with the guidance resources, a meeting should be scheduled at which the guidance counselor discusses with students such things as:

Occupational Outlook Handbook
Materials on Careers in General (pamphlets, bulletins, etc.)
Materials on Science Related Careers
Materials on Physics Related Careers
College Catalogs
Vocational and Technical School Catalogs
Information on Military Careers
Information on Apprenticeship Training and Labor Unions
Audio Visual Materials on Careers
VITAL Materials and how to use them.

II. Assessment of Student Abilities, Interests, Needs, and Values

An objective evaluation of student abilities, interests, needs and values should precede, and proceeed concurrently with, the consideration of tentative career choices.

Arrangement should be made with guidance department for students to fill out and interpret self evaluation forms.

III. Effective Use of Material in Appendix of This Curriculum Guide

Make copies of Appendix I (Physics Related Hobbies and Careers) and Appendix II (Occupational Study Outline). The student should be encouraged to make additions to these as seem appropriate.

Students should set up a list of procedures and rules for interviewing resource people--list some questions to be asked, compose a sample letter asking for an interview, consider some effective ways of expressing appreciation to resource people interviewed.

Area I: DESCRIPTION OF MOTION

Subject Guide

Area I can be classified as a study of kinematics. This is the study and description of motion without reference to the causes of motion. The focus is on the concepts of time, displacement, velocity, and acceleration and the relationships among these.

A good approach is for the teacher to make full use of experiments and techniques that simplify motion. The air track, air table and photographic methods are quite useful. Analysis of motion can be graphical or algebraic or a combination of the two. A good balanced approach is desirable to prevent naive over-reliance on formulas.

Vectors are introduced for working with displacement, velocity, and acceleration. Some students will find it difficult to work comfortably with vector components. The teacher may prefer not to attempt complete mastery of this area since there will be another opportunity for working with vector components in Area II.

It is important that the teacher work diligently early in the course to develop skills in unit analysis, evaluation of error, and significant figures as these skills are valuable throughout the course.

A discussion of celestial motion in Area I shows the universality of the laws of motion and provides further opportunity to study idealized motion.

Suggested Objectives

The student should (or should be able to):

1. Observe, measure, and analyze (both graphically and algebraically) straight line motion with (a) constant velocity and (b) constant acceleration. (PPC4,5,7;G6,7,8; M5,6;R3;GY2-2,3-1,3-2;V4)
2. Measure the earth's gravitational acceleration. (G9;V5; R1;PPC Film loops 1,2)
3. Observe, measure and analyze (graphically) straight line motion with non-constant acceleration. (GY2-1)
4. Analyze the paths of projectiles. (PPC10,11;G12;M12;V6; GY8-1;PPC film loops 5,6,7)
5. Use vectors to analyze quantitatively the acceleration of objects in circular motion.
6. Work problems relating time, distance, velocity, and acceleration (graphically or algebraically).
7. Distinguish between average and instantaneous quantities, and between scalar and vector quantities.
8. Chart the motion of and diagram the phases of the moon for a lunar period. (PPC14)
9. Using the earth as a frame of reference, describe the motion of the sun and the motion of the planets (including retrograde motion). (PPC17,19,20;PPC film loops 10A,10,11, 12).
10. Investigate Kepler's Laws of Planetary Motion. (M15; PPC film loops 16)
11. Summarize the contributions of Aristotle, Ptolemy, Copernicus, Brahe, Kepler, and Galileo to the concepts of motion.

Area I: DESCRIPTION OF MOTION

Career Exploration

The student will increase his skill in researching published records, organizing information, using resource people and communicating with people in established careers.

Career education relies heavily upon the use of resource people. It is important that the student be able to effectively express his appreciation for services rendered.

Selected for Exploration--

A. Hobbies and Recreation: Automobile Racing
   1. Make posters on cars used in automobile racing.
   2. Assemble records for various automobile racing tracks.
   3. Schedule a race driver talk to the class.
   4. Discuss the statement, "Race drivers are generally safe drivers".

B. Careers that Utilize Physics Principles: Gunnery
   1. Schedule talk by or interview with a retired military person (Consider taping and photographing interviews for an interview reference collection.).
   2. Look into the proposed legislation concerning legalization of fire arms. Be sure to look at both sides of the question.

C. Technology Careers: Heavy Equipment Operator
   1. Visit dealers for descriptive brochures on types of heavy equipment.
   2. Arrange talk by or interview with someone from Operating Engineers Union. Inquire about apprentice training in unions and procedures for gaining entrance into union jobs.

D. Careers Requiring a Fundamental Knowledge of Physics (B.S. Degree): Physical Therapist
   1. Do volunteer work at a physical therapy clinic.
   2. Interview a physical therapist. Inquire about such things as pre-work preparation, working conditions, and certification requirements.
   3. Make a bulletin board display of physics principles used in physical therapy.

E. Careers that Require a Substantial Knowledge of Physics: Meteorology
   1. Research weather conditions in your community for a specified period of time.
   2. Prepare a research paper on weather satellites. Include details of the orbits of those presently in space.

Area II: MECHANICS

Subject Guide

Area II includes a study of Newton's laws of motion, universal gravitation, conservation of momentum and energy, and fluid mechanics. In an area with such a wide range of elements it is easy to bog down in detail. The teacher will find it helpful to focus on the main concepts mentioned above and avoid spending too much time on any one topic.

In the discussion of Newton's laws many student difficulties may be avoided by the procedure of first defining an object for which the law is to be applied and then drawing the forces acting on it alone.

Another student difficulty arises in the understanding of action-reaction in Newton's third law. Special emphasis should be placed on the fact that action-reaction refers to forces acting on different objects. A similar problem occurs in the discussion of centripetal and centrifugal forces. The teacher should make the point that from an inertial frame of reference, the only force acting on the object in uniform circular motion is centripetal force. One may point out that objects in uniform circular motion move on a tangent (not outward) when released.

In Area II as throughout the course the student must learn to interpret experimental data. Students must realize that experimental results are never "wrong". The problem is to eliminate factors that interfere with the restricted area of study and to understand the influence of those factors that cannot be eliminated.

Suggested Objectives

The student should (or should be able to):

1. Observe, measure and analyze the forces acting on an object in equilibrium. (R5,6;GY6-1 part 1;V14,15,16,17; GY12-1;M7)
2. Determine quantitatively the relationship among force, mass, and acceleration. (PPC8,9;G11,20;M8,9;R4;GY4-1,5-1, 6-1 part 2;V8,9,20)
3. Verify Newton's Third Law by demonstrating that momentum is conserved. (PPC22,23;G14;M10,11;R7;V12,13;GY11-1,11-2, 11-3;PPC film loops 18 through 30, photographs of collisions shown in these film loops are shown pages 146-158 PPC handbook)
4. Work many problems involving Newton's Laws of Motion and Universal Gravitation.
5. Investigate the relationship among the period, radius, and centripetal force on an object with uniform circular motion. Discuss the result with respect to satellite motion. (PPC12;M13;R9;G8-2;V11)
6. Show that mechanical energy is conserved in some collisions but not in others. (R10,11;PPC22,23;G14;M10,11;R7;V12,13; GY11-1,11-2,11-3;PPC film loops 18 through 30. Many of these were cited in objective 3. They can be looked at again here for conservation of mechanical energy.)
7. Obtain graphs of force versus distance for such things as (a) a spring, (b) gravity near the surface of the earth, and (c) gravity far from the surface of the earth. Relate to potential energy. (M17;PPC film loops 30,32)
8. Do experiments on kinetic and potential energy. (G15;M16; R12,16;V18;G11-3,12-1,12-2)
9. Work many problems involving kinetic energy, potential energy.
10. Do experiments on fluid mechanics involving such concepts as specific gravity and fluid pressure, and such principles as Archimedes Principle, Pascal's Principle, and Bernoulli's Principle. (V19)

Area II: MECHANICS

Career Exploration

Among the skills that the student will have an opportunity to refine are: (1) letter writing, (2) using tools such as movie cameras, and (3) constructing display materials.

Selected for Exploration--

A. Hobbies and Recreation: Billards
   1. Make posters on techniques used in playing billards.
   2. Film or video tape part of a game of billards (One may even get some good sequences that can be analyzed for conservation of momentum.).
   3. Students who play billards talk to the class about the game.

B. Careers that Utilize Physics Principles: Traffic Policeman
   1. Ask a traffic policeman to talk to the class on accident investigation.
   2. Obtain information from Driver Education class on driving and safety habits.
   3. Assemble a bulletin board on automobile accidents. A collage of pictures of automobile accidents could be effective.

C. Technology Careers: Engineering Technician
   1. Make models of different types of machinery.
   2. Visit a bottling company. From memory sketch pictures of some of the people at work.

D. Careers Requiring a Fundamental Knowledge of Physics (B.S. Degree): Automotive Engineering
   1. Write automotive dealers asking for information on new automotive engineering.
   2. Submit a car design to a body design contest.
   3. Collect and display pictures of new automobiles.
   4. Compare performances of new automobiles.

E. Careers that Require a Substantial Knowledge of Physics: Astrophysics
   1. Acquire information from NASA on careers in astrophysics.
   2. Read science fiction book or play related to space. Analyze the situations involved for conformity or nonconformity with accepted physics principles.

Area III: THERMODYNAMICS

Subject Guide

To present the main physical content of thermodynamics, embodied in the first and second laws, the notion of thermodynamic equilibrium and the associated concept of temperature need to be carefully defined. The first law asserts that energy is conserved and that every system possesses energy content (called its internal energy). This law provides the proper definition of the heat absorbed by a system in a process as that part of the increase of the system's internal energy which is not attributable to work done upon it. The second law states that it is impossible to convert heat energy absorbed completely into work performed. This law permits definition of absolute temperature and of entropy. It is helpful to illustrate these laws and concepts with simple examples such as ideal gases, and to explain them from the molecular viewpoint. Attainment of equilibrium is characterized by molecular disorder (maximum entropy); heat absorption is understandable as molecular energy transfer without macroscopic displacement needed for performance of work; and the second law can be viewed as the assertion that for any process, with overwhelming probability, the molecular disorder of the universe increases with time. A study of the kinetic theory of gases illustrates the statistical character of thermodynamics when viewed from the molecular perspective.

Suggested Objectives

The student should (or should be able to):

1. Investigate temperature scales and their relationships. Develop skill in making temperature measurements. (PPC26;G24;M23;V22)
2. Examine the First Law of Thermodynamics by doing experiments in which the internal energy is changed (b) by performance of work on the system without heat being absorbed and (b) by heat absorbed by the system without the performance of work. (PPC27;G25,26,27;M17,18,20,42; GY11-3,12-1,16-1;V24,42;R25)
3. Make measurements of specific heat. (PPC27;M19;GY13-1)
4. Discuss the Second Law of Thermodynamics and the Concept of Entropy.
5. Discuss the operation of heat engines and refrigerators.
6. Investigate the ideal gas law. (PPC29;G28;M22;GY14-1;V25)
7. Inquire into the kinetic theory of gases. (PPC28)
8. Investigate the effect of temperature on volumes of solids, liquids, and gases. (M23;GY14-2;V22,23)
9. Do experiments involving change of phase. (PPC27;G26;M20; GY13-2)
10. Discuss the contributions of Joule, Rumford, Carnot, Watt, and Maxwell to the development of thermodynamics and kinetic theory.

Area III: THERMODYNAMICS

Career Exploration

These activities will provide an opportunity to improve his skill in organizing data, expressing ideas, and interacting effectively with peers and adults.

Selections for Exploration--

A. Hobbies and Recreation: Cooking
   1. Explain what is meant by the following: bake, broil, fry, simmer, deep fry, barbecue, smoke, etc.
   2. Assemble a display of cooking utensils.
   3. Make a collection of favorite recipes of classmates.
   4. Discuss physics principles involved in pressure cooking.

B. Careers that Utilize Physics Principles: Industrial Plant Operator
   1. Talk to an industrial plant operator about how he prepared for his job and about opportunities for advancement in his job.
   2. Present oral reports prepared from interviews with parents or friends who are plant operators.
   3. Visit an industrial plant and bring back pictures of industrial plant operators at work.

C. Technology Careers: Air Conditioning and Refrigeration Mechanic
   1. Visit an air conditioning class in a vocational school.
   2. Research the topic of Air Conditioning and Refrigeration Mechanic. Use Occupational Outline Handbook and other materials in the guidance department or library.

D. Careers Requiring a Fundamental Knowledge of Physics (B.S. Degree): Conservation Engineer
   1. Make a booklet containing short summaries of newspaper articles, television and radio advertisements, and magazine articles showing the need for conservation. Focus on careers that have developed or may develop to fill this need.
   2. Write to state and national conservation departments for information on careers in conservation.
   3. Summarize articles and display pictures from Louisiana Conservationist on water conservation in Louisiana. Consider the current status of fresh water supply in Louisiana.

E. Careers that Require a Substantial Knowledge of Physics: Petroleum Engineer
   1. Participate in Petroleum Engineer "Career Day" at nearby university.
   2. Look at College Catalogs for Curriculum requirements for petroleum engineers.

Area IV: WAVES

Subject Guide

The introduction of Hooke's law and simple harmonic motion is preparation for a study of waves. The basic relation, the velocity of a wave is the product of frequency and wavelength, applies to all waves, regardless of type or the medium through which they travel. The mechanical properties of the medium are invoked to explain the propagation of a wave in the medium. (This led to the famous impasse of the ether in the propagation of light.)

The superposition principle, the addition of the amplitudes of waves at a point, is applied to predict phenomena such as interference, as in standing waves and beats, and diffraction. Though the wave picture is the proper one for illustrating the propagation of light it can be advantageous to resort to ray diagrams in describing the light paths for reflection and refraction. The selected rays are perpendicular to the wave fronts. These are convenient to use in the laws of reflection and refraction as applied in the components of optical instruments.

Suggested Objectives

The student should (or should be able to):

1. Investigate Hooke's Law and simple harmonic motion. (V10;PPC30;G18,19)
2. Become familiar with terms related to waves such as: monocromatic, frequency, wavelength, speed of propagation, transverse, longitudinal, interference, reflection, refraction, and polarization.
3. Examine the properties and characteristics of waves. (G32, 35;M24,25,26,27,28,29;G20-1,20-2,20-3,20-4,20-5,21-2;V26,27, 28,29,32;R18,20)
4. Investigate standing waves. (G36;GY21-1;V30;R19)
5. Solve problems related to wave phenomena.
6. Examine diffraction and interference patterns for sound waves, ultra sound, microwaves, and light. (PPC31,M35;GY21-3,21-4, 21-5;V35;R22)
7. Investigate the spectrum of electromagnetic waves. (M32)
8. Investigate the reflection and refraction of light. (PPC32; G33,34;M30,31,33,34;GY18-1,18-2,19-1,19-2;V31,32,33,34;R21)
9. Examine the principles of optical instruments such as microscopes, telescopes, cameras, binoculars, and the eye. (G37)
10. Discuss color with emphasis on absorption and reflection.
11. Describe some of the classical experiments for measuring the speed of light.
12. Discuss the Doppler effect.
13. Discuss the contributions of Huygens, Young, Fraunhofer, and Fresnel to our understanding of wave phenomena.

Area IV: WAVES

Career Exploration

The student will further develop his capacity to organize and evaluate information, and to put together effective presentations.

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Selected for Exploration--

A. Hobby and Recreation: Photography
   1. Make bulletin boards using photographs taken by members of the class.
   2. Take pictures of students in the class.
   3. Use an invention time line to trace the development of photography.
   4. Arrange a contest to find "Oldest" picture. (Must be able to approximately document picture's age in some way.)

B. Careers that Utilize Physics Principles: Telephone Lineman
   1. Interview a representative from the telephone company about jobs with the company.
   2. Put together a slide presentation using pictures of telephone linemen.
   3. "Role play" an applicant for a job as telephone lineman.

C. Technology Career: Optician
   1. Contact employment services to determine job openings for people with optician training.
   2. Survey brochures describing optician schools.

D. Careers Requiring a Fundamental Knowledge of Physics (BS. Degree): Acoustics Engineer
   1. Make bulletin boards, posters, collages and mobiles to show the need for and work of acoustics engineers.
   2. Attend a pep meeting or school dance. Report to the class on the need for attention to acoustical design in areas where such activities are held.
   3. Make measurements of sound intensity in various places in your community.

E. Careers that Require a Substantial Knowledge of Physics: Astronomer
   1. List traits and characteristics that are desirable for an astronomer to have. Compare this list with a list made by students of their own characteristics.
   2. Arrange a "stargazers" party at which to identify constellations, planets, etc. Be sure to invite a professional or amateur astronomer.
   3. Visit an observatory or a planetarium.

Area V: ELECTRICITY AND MAGNETISM

Subject Guide

The main concepts of this area are: Coulomb's Law, the production of magnetic fields by currents, the forces of magnetic fields on currents, the production of electric fields by changing magnetic fields, and the production of magnetic fields by changing electric fields. A basic principle is the conservation of charge. Electric and magnetic fields can carry energy and momentum, and therefore are realities and not merely mathematical conveniences. In the analysis of circuits, Ohm's Law is fundamental.

An explanation of the proper use of meters is suggested before experiments on circuits. Further study of meters could include: how a galvanometer works, the construction of a simple galvanometer, and the use of a galvanometer as a voltmeter and as an ammeter.

Suggested Objectives

The student should (or should be able to):

1. Relate static charge to atomic structure. (PPC Exp. 34)
2. Investigate generation and properties of static charge. (M36, 37;GY9-3;V37)
3. Work problems involving Coulomb's Law. (M37;V38)
4. Describe and demonstrate sources of direct current.
5. Investigate the effects of temperature, length, and cross-sectional area of conductors to their resistance. (V41;R26)
6. Design and assemble simple d.c. circuits and make voltage, current, and resistance measurements on them. (G23,29,30;M38, 39,40,41;GY10-3,10-4;V40,46,47;R24,27)
7. Work d.c. circuit problems dealing with Ohm's Law and Kirchhoff's Laws.
8. Investigate Faraday's Laws of Electrolysis. (PPC40;V39)
9. Examine the magnetic field produced by steady current and the force which a magnetic field exerts upon current. (PPC37;G22; M44,45,46;G10-1,10-2,17-2;V43,44;R23,28,29)
10. Build a simple d.c. motor and simple d.c. meters. Discuss the principles involved. (PPC activity page 266;M49)
11. Investigate Faraday's Law of Electromagnetic Induction and discuss its application to the generation of electrical power. Read an electric meter and calculate the electric bill. (PPC 39,G22-1,22-2;V45,48;R30,31)
12. Investigate problems involving a.c. circuits with such components as resistors, capacitors, inductors, transformers, tubes, transistors, etc. (G31;PPC39B;V49,50,51)
13. Summarize the contributions to the understanding of electricity and magnetism of Gilbert, Oersted, Volta, Faraday, Ampere, Coulomb, Maxwell, Ohm, Franklin, and Edison.

Area V: ELECTRICITY AND MAGNETISM

Career Exploration

Skills in assessing employment trends, making surveys, and organizing information will be re-enforced by the activities in this area.

Selected for Exploration--

A. Hobby and Recreation: Ham Radio Operator
   1. Research licensing laws for ham radio operators.
   2. Arrange for a local ham radio operator to set up a third party contact in another country.
   3. Investigate the cost of ham radio as a hobby.
   4. Talk with a ham radio operator about public service opportunities available to ham operators.

B. Careers that Utilize Physics Principles: Homemaker
   1. Make a bulletin board display using pictures of household appliances. Indicate some of the physics principles involved in their operation.
   2. Write and present a skit showing some aspect of the homemaker's association with electricity. Possible themes are:
      (a) Jobs that have switched from "grindstone" to "pushbutton".
      (b) "Kitchen Crisis" showing short circuits, overloading, appliance noise, etc.
   3. Conduct a neighborhood survey assessing what homemakers know about principles involved in operation of household appliances.
   4. Work up a safety check list for household appliances. Use the check list to run a safety check.

C. Technology Careers: Small Appliance Repairman
   1. Conduct a survey of small appliance breakdown in the home. Data should include (a) age at time of breakdown, (b) cost of repair parts, (c) cost of labor, etc.
   2. Visit a small appliance repair class in a vocational school.
   3. Interview self employed repairmen to find out how they set up a business.
   4. Arrange for a repairman to demonstrate repairing an appliance.

D. Careers Requiring a Fundamental Knowledge of Physics (B.S. Degree): Industrial Technology-Instrumentation
   1. Contact industrial plants to find out how many instrument men they employ.
   2. Survey want ads in newspapers for job openings for instrument men.

E. Careers that Require a Substantial Knowledge of Physics: Electrical Engineer
   1. Contact employment companies that advertise for E.E.'s. Inquire about entry level experience required and chances for advancement.
   2. Consult college catalogs for degree requirements for electrical engineers.

Area VI: MODERN PHYSICS

Subject Guide

Modern physics consists of two major 20th century developments: Einstein's relativity and quantum mechanics. Relativity (the special theory) can be developed fully, based on the two assumptions that all inertial reference systems are equivalent and that the speed of light has a constant value for all inertial reference frames. Quantum mechanics has not been presented comprehensively in high school physics texts. Instead, most of the relevant historical developments and some of the basic concepts are discussed qualitatively and some description of atomic and nuclear structure has been given (without rigorous derivation). Discussion of these should include the statistical interpretation of the deBroglie wave associated with the motion of a particle. Also a careful delineation of the range of validity of the Bohr theory needs to be made. The student should be left with some insight into the modern view of the atom and with a qualitative explanation of the periodic table of the elements. Since there does not exist a satisfactory theory of nuclear structure, a study of the nucleus remains at a phenomenological level of investigation. Finally, it may be noted that physics is not a closed subject--the mysteries of nature still present an unresolved, exciting challenge.

Suggested Objectives

The student should (or should be able to):

1. Summarize the concept of the ether and describe the Michelson-Morley experiment.
2. Explain the equivalence of inertial reference frames and the constancy of the speed of light for all inertial reference frames.
3. Describe time dilation, length contraction, velocity "addition", and existence of the absolute limit of speed, namely the speed of light.
4. Examine relativistic corrections to Newton's Second Law and to the Law of Conservation of Energy. Consider how these alterations relate to the dependence of mass upon speed and to the equivalence of mass and energy.
5. Enumerate many observed properties of matter explainable in terms of atoms and molecules. (PPC40;M21;V21;PPC film loop46)
6. Examine some of the phenomena that suggest the dual character of light and matter. (G38;R33;look again at PPC31,M35,GY21-3, 21-4,21-5,V35;R22 which were done earlier in Area IV)
7. Compare and contrast the particle and the wave descriptions of light and matter. Reconcile this duality by use of the statistical interpretation of deBroglie's wave associated with the motion of particles.
8. Discuss the Uncertainty Principle.
9. Measure the charge of the electron. (PPC42;GY17-1)
10. Determine experimentally the mass (e/m) of the electron. (PPC41;M47;GY17-3;V52;R32)
11. Observe and investigate atomic spectra. (PPC44;R34)
12. Describe Rutherford's Scattering experiment and discuss its historical significance.
13. Examine radioactive radiations and transformations. (PPC45, 46,47,48;G39;M50,51;V54,55;R35,36;PPC film loop 49)
14. Summarize the contributions to modern physics of Thomson, Curie, Planck, Einstein, Bohr, Rutherford, Chadwick, Compton, and Fermi.

Area VI: MODERN PHYSICS

Career Exploration

Many types of communication skills will be strengthened through contact with the professional public and with resource people. The student will continue to develop skill in collecting and organizing information.

Selected for Exploration--

A. Hobbies and Recreation: Science Fiction Reading
   1. Arrange a panel discussion on science fiction.
   2. Arrange a display shelf and lending library of paperback science fiction.
   3. Summarize science principles involved correctly in selected science fiction stories. Also point out incorrect applications of science principles in selected stories.

B. Careers that Utilize Physics Principles: Nuclear Power Plant Operator
   1. Assess job opportunities in the new nuclear power plants in Louisiana.
   2. Make a wall chart or map showing the location of nuclear power plants.
   3. Determine hiring practices of and on-the-job training available to employees of nuclear power plants.

C. Technology Careers: Nuclear Technician-Medical
   1. Visit a hospital or other facility to see a nuclear technician at work.
   2. Role play the following themes:
      (a) Ways in which a citizen can help assure that technological innovations will be used in a manner benefiting society as a whole.
      (b) Differences between technology and basic science.

D. Careers Requiring a Fundamental Knowledge of Physics (B.S. Degree): Radiology
   1. Research radiology sub-fields. Report to the class on recent developments and possible future careers.
   2. Debate "Are nuclear technological advances good for our society?".
   3. Schedule a talk by a radiology instructor or a practicing radiologist.

E. Careers that Require a Substantial Knowledge of Physics: Research Physicist
   1. Make a field trip to a nuclear center at a university or to a nuclear power plant.
   2. Research the life of a well known nuclear physicist, past or present. List his qualifications and personal characteristics that contribute to success in his career.

CULMINATING CAREER ACTIVITIES

1. COMMUNICATING INFORMATION TO OTHERS

OBJECTIVE
Students will pass on some of the career information they have obtained to other students not engaged in this program - and to any interested students in the high school.

ACTIVITIES
Students should get permission from the Principal to set up tables in a main area of the school during some time of day when students would be free to look over material on display. Reports and pamphlets on different careers could be displayed and students could be present to answer any question on Physics-related hobbies and careers.

Students could put on a Science Career program to be held in the evening. Resource people whom the students have contacted could be asked to help with this. These people could be located in separate rooms and the students allowed to circulate and talk to them informally. An alternative method would be to organize a program or a panel discussion using several of the resource people and all of the students would attend this one program. Students from other high schools could be invited to participate.

CAREER-ENTRY SKILLS ACQUIRED IN THESE CAREER ACTIVITIES
Organizing presentations, communicating information to other people.

2. STUDENT EVALUATION OF CAREER EXPLORATION AND ACQUISITION OF CAREER-ENTRY SKILLS

OBJECTIVE
Students and teacher will evaluate this career education guide at the end of the academic year and make recommendations for additions or changes deemed necessary for more effective use the following year.

ACTIVITIES
Students in a class activity will prepare a list of points that each student should consider in his evaluation of the program and how effective it has been in helping him gain knowledge of Physics-related hobbies and careers. Include in this an evaluation of how effective it has been in helping each student crystallize his ideas about his own career. This should be a comprehensive list in order to achieve the objective.

Each student will then prepare a written evaluation covering all of the points in the list which they prepared in the above activity.

Ask two or three students to study these and summarize the recommendation. The students should present this to the class for group study and discussion.

A final summary and the proposed changes to be incorporated into the program for the next year can be prepared by the students and teacher together.

CAREER-ENTRY SKILLS ACQUIRED IN THESE ACTIVITIES

Students gain experience in evaluating a program, preparing reports, summarizing reports, and proposing changes in a program in order to improve it.

APPENDIX I. PHYSICS-RELATED HOBBIES AND CAREERS

A. HOBBIES AND RECREATIONAL ACTIVITIES THAT INVOLVE PHYSICS PRINCIPLES (A Knowledge of Physics Might be Beneficial)

Hobbies

- Astronomy
- Auto Racing
- Boating and Sailing
- Ceramics
- Electronics
- Flying
- Ham Radio
- High Fidelity
- Hunting
- Kite Flying
- Metal Working
- Mini-Bikes and Go-Carts
- Model Airplanes
- Model Rocketry
- Model Trains
- Motorcycles
- Music
- Photography
- Printing
- Powerboat Racing
- Telescope-making
- Woodworking

Athletics and Sports

- Archery
- Badminton
- Baseball
- Basketball
- Billiards
- Bicycling
- Bowling
- Football
- Golf
- Gymnastics
- Handball
- Mountain Climbing
- Riflery
- Rugby
- Snow Skiing
- Soccer
- Swimming
- Tennis
- Track and Field
- Water Skiing
- Weightlifting
- Wrestling

B. PHYSICS-RELATED CAREERS*

1. CAREERS THAT UTILIZE PHYSICS PRINCIPLES

Careers Requiring a High School Diploma or Less; A Knowledge of Physics an Asset.

NOTE: Many of these fields can be entered through apprentice training programs or through vocational-technical schools. Therefore, Groups 1 and 2 overlap. On-the-job training may be available. The amount of training varies widely.

- Business Machines Repair and Sales
- Building Contractors
- Cropdusting
- Fireman (firefighting)
- Housewife/Homemaker

Industrial Crafts and Building Trades

- Brick and Stone Mason
- Cabinetmaker
- Carpenter
- Coremaker

*This classification is arbitrary and subject to individual judgment or discretion by the user. It is not intended to be an exhaustive list. There is of necessity some overlapping in classifications. In some cases the amount of Physics involved is not well-defined.

Industrial Crafts and Building Trades (continued)
- Electrician
- Forger/Welder
- Millwright
- Operating Engineer (Equipment)
- Plumbers-Pipefitters
- Sheetmetal Worker
- Ship Fitter
- Steam Fitter
- Tool and Diemaker

Industrial Plant Operator

Mechanics
- Auto
- Auto Body and Fender Repair
- Aircraft Engine
- Diesel Engine
- Farm Equipment
- Small Engine

Miner

Musician

Photoengraver

Photographic Laboratory Technician

Piano Tuner

Policeman

Retail Sales

Telephone
- Lineman
- Repairman
- Cable Splicer

Tree Service

Truckdriving

Wrecking Contractors (Building Demolition)

2. TECHNOLOGY CAREERS REQUIRING A BASIC KNOWLEDGE OF PHYSICS

NOTE: Many of these fields can be entered through apprentice training programs or through vocational-technical schools. The amount of training required varies widely.

a. Careers Probably Requiring High School Physics

Air Conditioning, Refrigeration Mechanics and Service

Airline Pilot

Computer Service Technician

Draftsman

Electronics Technology

Engineering Technicians

Instrumentation Technology

Technical Sales

Medical
- Dental Technician
- Laboratory Assistants
- Medical Technicians
- Nuclear Medicine Technician
- Nursing
- Physical Therapy Assistant
- X-Ray Technician

b. Careers Requiring Knowledge of Specific Concepts of Physics

Appliance Repairman
Athletic Trainer
Audiologist
Criminal Investigation
Graphic Arts (typesetting)(printing)
Heavy Equipment Operators
Industrial Trades and Building Crafts
  Carpenter
  Electrician
  Machinist
  Plumber
  Sheet Metal Worker
  Welding
Jeweler
Mechanics
  Auto
  Auto Body and Fender Repair
  Aircraft Engine
  Diesel Engine
  Farm
  Small Engine
Mortician
Office Machine Repair
Optics-Optician
Photography
Radio and TV
  Broadcast Technicians
  Recording Engineers
  Operation
  TV Filming
Surveyor
Watchmaker

3. CAREERS REQUIRING A FUNDAMENTAL KNOWLEDGE OF PHYSICS
B.S. Degree or Higher - One Year College Physics Required

Agricultural Science
Architecture
Biological Sciences
Earth Science
Engineering
  Agricultural
  Acoustical
  Automotive
  Biomedical
  Ceramics
  Conservation
  Engineering Science - Computer Systems
  Engineering Design Technology
  Environmental
  Fire Protection
Engineering (continued)
  Flight
  Forest
  Geological
  Highway
  Industrial
  Manufacturing
  Marine
  Sanitary
  Soil
  Traffic
Entomology
Environmental Science
Food Science
Forestry and Wildlife

Geology
Industrial Arts Education
Industrial Technology
Mathematics
Medical Sciences
  Chiropractor
  Cytotechnology
  Dentistry
  Dental Hygienist
  Medical Technology
Medical Sciences (continued)
  Nuclear Medicine Technology
  Occupational Therapy
  Optometry
  Pharmacy and Pharmacology
  Physical Therapy
  Podiatry
  Radiologic Technology
  Veterinary
Patent Attorney
Vocational Trade and Industrial Education

4. CAREERS THAT REQUIRE A MAJOR IN PHYSICS OR A SUBSTANTIAL KNOWLEDGE OF PHYSICS
B.S. or Higher Degree

Aerospace
Astronomy
Astrophysics
Atomic and Nuclear Science
Aviation and Space Sciences
Biophysics
Biochemistry
Chemistry
Computer Sciences
Electronics
Engineering
  Aeronautical
  Bioengineering
  Chemical
  Civil
Engineering (continued)
  Electrical
  Mechanical
  Metallurgical
  Mining
  Nuclear
  Petroleum
  Plastics
  Safety
  Sugar
Geophysics
Meteorology
Oceanography - Physical
Physics
Science Teaching - College and Secondary

APPENDIX II. OCCUPATIONAL STUDY OUTLINE

A. NAME OF OCCUPATION:

B. DUTIES OF THE OCCUPATION:

C. QUALIFICATIONS: What are the personal requirements?

D. AGE: How old must I be to enter the occupation?

E. SEX: Is this an occupation in which others of my sex are normally employed?

F. SPECIFIC PHYSICAL AND HEALTH REQUIREMENTS: Am I corrrect height to do the work? Are my eyesight and hearing adequate? Am I strong enough?

G. INTEREST: Do I possess this interest? If not, could I develop interest in this type of work? Would I be happy doing this type of work?

H. ABILITIES: Do I possess the required abilities? If not, could I acquire the knowledge and skills necessary to do the job?

I. PERSONALITY: Do I possess the personal qualities necessary for doing this type of work? If not, could I develop these qualities?

J. VALUES AND ATTITUDES: Does anything about this job violate values and attitudes I have about people and work? If so, could I adjust to situations that required I change my values and attitudes?

K. PREPARATION: What subjects do I need to study? What special training will I need? How long will it take to receive this training? How much will it cost? Can I get this training within the state? Is work experience required for entry into this occupation? What is the method of entry into this occupation? Are any scholarships available for the education required?

L. WORKING CONDITIONS ON THE JOB: Is it hazardous work? Is it noisy or dirty? Will I work alone or with a group? Does the work require being away from home for long periods of time?

M. EMPLOYMENT OPPORTUNITIES: How much is the beginning pay? What is the salary range? What are the opportunities for advancement? Will additional education be needed for promotions? If so, will the employer offer any assistance in additional education?

N. EMPLOYMENT OUTLOOK: How many are employed in the occupation at present? Are there employment opportunities in my community or state for thie type of work?

O. SPECIAL REQUIREMENTS: (Such as certification, licenses, and examinations)

APPENDIX III. SUGGESTIONS FOR TEACHING-LEARNING ACTIVITIES

Below are listed ideas which might be helpful in planning for varied types of teaching-learning situations.

1. Interviews
2. Skits
3. Theme writing
4. Bulletin board
5. Debates
6. General discussion
7. Small group discussion
8. Committee work
9. Individual or group study
10. Oral reports
11. Newspaper articles
12. Field trips
13. Movies
14. Filmstrips
15. Slides
16. Overhead or opaque projections
17. Collect want ads
18. Write want ads
19. Employment Commission job lists
20. Exhibits
21. Collect materials
22. Observations
23. Role playing
24. Resource person
25. Brainstorming
26. Games
27. Research projects
28. Demonstrations
29. Prepare lists
30. Radio and television programs
31. Projects
32. Illustrations
33. Chalktalks
34. Panel discussions
35. Make files
36. Tests
37. Problem solving
38. Prepare charts and graphs
39. Window displays
40. Write letters
41. Assigned reading
42. Thought problems
43. Prepare speeches
44. Notebooks
45. Lecture

(From Introduction to Vocations, Teacher's Guide, Course Number 799, July, 1965, prepared by H. E. Beam and J. R. Clary, North Carolina).

APPENDIX IV

JOURNALS

The American Journal of Physics

Contemporary Physics

Journal of Research in Science Training

The Louisiana Physics Teacher
(not available in libraries; contact
Henry Garon, Editor
Physics Department
Loyola University
New Orleans, Louisiana 70118)

Physics Education

The Physics Teacher

Physics Today

School Science and Mathematics

School Science Review

Science and Children

Science Digest

Science News

The Science Teacher

Scientific American

PROFESSIONAL ORGANIZATIONS

The American Association of Physics Teachers
335 East 45th Street
New York, N. Y. 10017

The Louisiana Academy of Sciences
Dr. Bruce Boudreaux, Permanent Secretary
Department of Entomology
Louisiana State University
Baton Rouge, Louisiana 70803

The Louisiana Education Association
P. O. Box 73882
Baton Rouge, Louisiana 70807

The Louisiana Science Teachers Association
Mrs. La Wana Stewart, President
Metairie Park Country Day School
300 Park Road
Metairie, Louisiana 70005

The Louisiana Section, American Association of Physics Teachers
Dr. Edward G. Grimsal, Jr., Secretary-Treasurer
Box 4210
University of Southwestern Louisiana
Lafayette, Louisiana 70501

The Louisiana Teachers' Association
P. O. Box 1906
Baton Rouge, Louisiana 70821

The National Science Teachers' Association
1201 16th Street, N.W.
Washington, D. C. 20036